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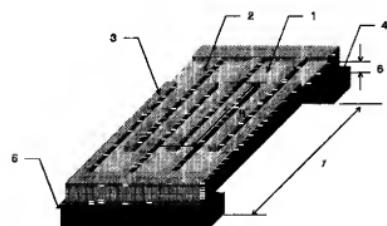
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(54)【発明の名称】 弾性波素子

(57)【要約】

【課題】端面反射型振動子の振動原理を基本的に用い、前記厚み滑り振動子と同様の温度変動特性が得られ、且つ実用上の容量比を小さく出来る新規な構成の弾性波素子を提供する。

【解決手段】圧電基板と、前記圧電基板の少なくとも表面のいずれかの面に形成されたすだれ状電極とを有し、前記すだれ状電極により生成される弾性波振動の前記圧電基板を伝搬する面を機械的にフリーとし、更に前記圧電基板の厚さを前記弾性波振動の波長より小さくしたことを特徴とする。



【特許請求の範囲】

【請求項1】圧電基板と、

前記圧電基板の少なくとも表裏のいずれかの面に形成されたすだれ状電極とを有し、

前記すだれ状電極により生成される弹性波振動の前記圧電基板を伝搬する面を機械的にフリーとし、更に前記圧電基板の厚さを前記弹性波振動の波長より小さくしたことと特徴とする弹性波素子。

【請求項2】請求項1において、

前記圧電基板の厚さが、前記弹性波振動の波長に対し、0.5入以下であることを特徴とする弹性波素子。

【請求項3】請求項1において、

前記圧電基板の少なくとも表裏両面に同一パターンのすだれ状電極が形成され、

前記圧電基板の表裏両面における振動が結合共振することと特徴とする弹性波素子。

【請求項4】請求項1又は3において、

前記圧電基板の弹性波振動が充分に減衰する両端部位に固定部を有し、前記固定部間の距離が、前記弹性波振動の波長に対し、5入以上であることを特徴とする弹性波素子。

【請求項5】請求項3において、

前記圧電基板の側面に電極が形成され、該側面に形成された電極で前記圧電基板の表裏両面に形成されたすだれ状電極間を電気的に接続することと特徴とする弹性波素子。

【請求項6】請求項1において、

前記圧電基板のすだれ状電極の形成された面と反対側の全面にペタ電極が形成されていることを特徴とする弹性波素子。

【請求項7】請求項1において、

前記圧電基板の端面を前記弹性波振動の反射面とすることを特徴とする弹性波素子。

【請求項8】請求項1において、

前記圧電基板に形成されたすだれ電極の両側に反射器用グレーティング電極又は、グループが形成されていることを特徴とする弹性波素子。

【請求項9】請求項3において、

前記圧電基板の表裏両面に形成されたすだれ電極の一方を、電気的に短絡又は、負荷インピーダンスで終端した構成とすることと特徴とする弹性波素子。

【請求項10】請求項1において、

前記圧電基板と、LiTa_{0.5}又は、LiNbO₃基板を用い、結晶軸方位がZ軸を中心にY軸を36±20°回転した包帯で切り出され、弹性振動の伝播方向をX方向とすることと特徴とする弹性波素子。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、弹性波素子に関し、特に高周波帯の高安定化を実現した弹性波素子に関

する。

【0002】

【従来の技術】近年、電子機器の動作周波数の高周波化に伴い、電子機器に用いられる例えば、マイコンクロック用の振動子、発振器などの弹性波素子の高周波化・高安定化が必要とされている。

【0003】弹性波素子における従来の技術は一般的に、厚み滑り振動を用いたものが主流で、また、特殊なものではBGS (Bleustein-Gulyaev-Shimizu/Nakamura) 波を用いた端面反射型振動子が使用されている。

【0004】前記の厚み滑り振動子では基板の両面に電極を設け、それらの電極間に駆動信号を与え、振動波は基板の厚み方向で生じる構成である。したがって、振動波が高周波になるに連れて素子基板の厚みが薄くなり、かつ厚み精度が重要である。このために、厚み滑り振動子にあっては、精度の高い素子の加工技術が必要とされていた。

【0005】一方、端面反射型振動子では、基板の一面に形成された駆動電極により基板表面に弹性波が生じる構成である。このために振動周波数は素子基板の厚みに依存しないので、素子の加工は比較的容易であるという特徴を有する。しかしながら、厚み滑り振動子に較べ、使用する温度環境により周波数の変化が大きいという問題を有している。

【0006】さらに、端面反射型振動子では、基本的に並列共振回路で表される等価回路における抵抗成分と直列に存在する容量と抵抗成分と並列に存在する容量との比(容量比)が大きく、このために一般に用途が限られていた。

【0007】

【発明が解決しようとする課題】したがって、本発明の目的は、上記の端面反射型振動子の振動原理を基本的に用い、前記厚み滑り振動子と同様の温度変動特性が得られ、且つ実用上の容量比を小さく出来る新規な構成の弹性波素子を提供することにある。

【0008】

【課題を解決するための手段】上記の本発明の目的に鑑みて、本発明者は新規な構成上のアプローチにより好ましい特性を得たものであり、本発明に従う弹性波素子は、圧電基板と、前記圧電基板の少なくとも表裏のいずれかの面に形成されたすだれ状電極とを有し、前記すだれ状電極により生成される弹性波振動の前記圧電基板を伝搬する面を機械的にフリーとし、更に前記圧電基板の厚さを前記弹性波振動の波長より小さくしたことを特徴とする。

【0009】上記本発明の目的を達成する弹性波素子の好ましい実施の形態例として、前記圧電基板の厚さが、前記弹性波振動の波長に対し、0.5入以下であることを特徴とする。

【0010】さらに、上記本発明の目的を達成する弹性

波素子の好ましい実施の形態例として、前記圧電基板の少なくとも表裏両面に同一パターンのすだれ状電極が形成され、前記圧電基板の表裏両面における振動が結合共振することを特徴とする。

【0011】また、上記本発明の目的を達成する弹性波素子の好ましい実施の形態例として、前記圧電基板の弹性波振動が充分に減衰する両端部位に固定部を有し、前記固定部間の距離が、前記弹性波振動の波長に入対し、5入以上であることを特徴とする。

【0012】さらにまた、上記本発明の目的を達成する弹性波素子の好ましい実施の形態例として、前記圧電基板の側面に電極が形成され、該側面に形成された電極で前記圧電基板の表裏両面に形成されたすだれ状電極間を電気的に接続することを特徴とする。

【0013】さらに、上記本発明の目的を達成する弹性波素子の好ましい実施の形態例として、前記圧電基板のすだれ状電極の形成された面と反対側の全面にベタ電極が形成されていることを特徴とする。

【0014】また、上記本発明の目的を達成する弹性波素子の好ましい実施の形態例として、前記圧電基板の端面を前記弹性波振動の反射面とすることを特徴とする。

【0015】さらに、上記本発明の目的を達成する弹性波素子の好ましい実施の形態例として、前記圧電基板に形成されたすだれ電極の両側に反射器用グレーティング電極又は、グループが形成されていることを特徴とする。

【0016】さらにまた、上記本発明の目的を達成する弹性波素子の好ましい実施の形態例として、前記圧電基板の表裏両面に形成されたすだれ電極の一方を、電気的に短絡又は、負荷インピーダンスで終端した構成することを特徴とする。

【0017】さらに、上記本発明の目的を達成する弹性波素子の好ましい実施の形態例は、前記圧電基板としてLiTaO₃又は、LiNbO₃基板を用い、結晶軸方位がZ軸を中心Y軸を36°±20°回転した包囲で切り出され、弹性振動の伝播方向をX方向とすることを特徴とする。

【0018】本発明の特徴は、更に以下の図面を参照して説明される実施の形態から明らかになる。

【0019】

【発明の実施の形態】図1は、本発明による第1の実施例を示す圧電素子の斜視図である。圧電基板1の表裏両面上に駆動電極2、3が同じパターンで形成されている。さらに、圧電基板1の長手方向で駆動電極2、3と電気的機械的に接合された電極パッド4、5を通して圧電基板1の一面側(図1では、裏面側)の駆動電極2、3と入出力を行なう。

【0020】この圧電素子の電気的等価回路が図2に示される。容量C_a、インダクタンスL及び抵抗Rの直列接続と、この直列接続に対して並列接続される容量C_b

を有する。先に言及した容量比は、前記直列容量C_aと並列容量C_bの比γを指し、 $\gamma = C_b / C_a$ で表される。この容量比γが大きいと圧電素子の利用の制限が大きくなってしまうことが当業者に知られている。

【0021】次に、図1の構成を有する圧電素子の一試作例について、以下に説明する。電極パッド4、5に接続される図1の裏面に形成される駆動電極2、3により圧電基板1の表面上に弹性波振動が生成される。

【0022】そして、この弹性波振動の波長を入とした時、試作例の圧電基板1の厚み(H)6は0.25入の関係にあり、電極パッド4、5により空中に浮いた部分の長さ(LF)7は1.5入であった。

【0023】駆動電極材にはNiCr/Au(膜厚5.0nm/4.0nm)を用い、駆動電極2、3によるすだれ状電極の交差する長さ8が5入、かつ電極の対数は1対である。すだれ状電極は表裏面に配置し、駆動する電極即ち、電極パッド4、5に接続される駆動電極は図1の裏面側のものである。

【0024】さらに、圧電基板1には結晶軸XYZに関して、Z軸を中心Y軸を40°回転した角度で切り出され、X方向の振動波の伝播方向を有する、40°YカットX方向伝播のLiTaO₃基板を用いた。

【0025】上記構成の条件で試作した振動子は、図2に示される等価回路の各要素に関する定数は下表に示す如くであった。

【0026】

【表1】

R	63.9	Ω
L	16.57	mH
C _a	0.142	pF
C _b	1.775	pF

したがって、上記試作例の容量比γは、 $\gamma = C_b / C_a = 12.5$ である。

【0027】図3は上記図1の構成の圧電素子について、波長入で正規化した基板厚み(H/入)と容量比(γ)の関係を示す図である。この図から容易に理解出来るように、圧電基板1を薄板化するに従い容量比が減少していくことが理解できる。従来の圧電素子は、一般的値として容量比は、7.0~8.0の大きさであった。これに対し、本発明の原理に従い、基板厚み(H/入)を1以下にすることにより、従来の圧電素子における容量比以上の容量比を得ることが可能である。さらに、圧電基板1の厚みを0.5入以下とすることが効果として顕著である。

【0028】図4は、図1の構成の圧電素子について電極の交差する長さ(8)を5入、電極の対数を1対および3対とした時の波長入で正規化した圧電基板厚み(H

／入)と温度変動率 10^{-6} (ppm) /°Cの関係を示す図である。

【0029】この図から圧電基板1の厚み (H／入) は薄い程、電極対数は少ない程、温度安定度 (温度変動率度) が高くなることが理解できる。なお、図4において、電極対数が多くなると温度安定度は、電極対数によらず一定値に収束すると考えられる。したがって、図4において電極対数10の破線は予想値である。

【0030】従来の圧電素子における温度安定度は、一般に $4.0 \text{ ppm}/\text{°C}$ 程度であるのに対し、圧電基板1の厚み (H／入) を1以下とすることにより従来の圧電素子における温度変動率を 4.0×10^{-6} 以下にすることが可能である。

【0031】図5は、更に温度変動率を室温 25°C で基準値零として、厚み滑り振動子と端面反射振動子の特性及び本発明の特性を比較した図である。図中、横軸を温度、縦軸を変動率ppmとし、特性線Aは厚み滑り端面振動子の温度変動特性及び、特性線B、Cは、それぞれ端面反射振動子及び本発明構成の圧電振動子の温度変動特性である。

【0032】ここで、温度変動率は、一般に最も低い値を頂点として有する二次曲線特性を示す。図5において、先に説明したように、厚み滑り振動子は、温度変動特性 (特性線A) は安定していて、常温 (25°C) 近傍に頂点を有する。これに対し、端面反射振動子の常温 (25°C) 近傍で温度変動 (特性線B) は大きく、更にその特性曲線の頂点は、常温より遙か上 (図5で少なくとも 7.5°C 以上であることが理解される) にある。本発明は、基本構造として端面反射振動子に類似であるが、厚み滑り振動子に近似の温度変動特性 (特徴線C) が得られる。

【0033】ここで、上記の説明から、本発明による温度安定度及び、容量比の低減の効果を得るために、駆動電極2、3により生成される弹性振動が伝搬する部分のみ所定の基板厚み (H／入) の範囲であればよい。

【0034】したがって、取り扱いを容易とするための構造として図6の実施例構造が可能である。図6では、圧電基板1の電極パッド4、5に接続する両端部であって圧電素子を固定する部分10、11以外の弹性振動が伝搬する領域のみを所定厚さ (1入) 以下とする構造である。この両端部では、弹性波振動は、充分に減衰されている。

【0035】また、図6の実施例構造における圧電素子を固定する部分10、11の間の長さである弹性振動が伝搬する領域の長さを (LF) とするとき、共振抵抗値との関係が得られる。図7は、図7の実施例構造におけるLFと共振抵抗値の関係を示す図である。この図からLFが5入以上であれば、好ましい小さな共振抵抗の一 定値が得られることが理解できる。

【0036】次に上記図1の本発明の基本構造におい

て、駆動電極2、3の拡張的变形例を説明する。

【0037】図8は、図1に示す構造に対し、駆動電極2、3の第1の拡張的变形例である。圧電基板1の両面に形成される駆動電極2、3を電気的に接続する側面電極12、13を圧電基板1の側面に形成した実施例構成である。

【0038】このように、側面電極12、13を備えることにより、圧電基板1の表裏において、弹性振動が生じ、従って振動の駆動効率をより高めることが可能である。

【0039】図9は、図1に示す構造に対し、駆動電極2、3の第2の拡張的变形例である。圧電基板1の両面に形成される駆動電極2、3の一方即ち、入出力電極パッド4、5に接続される側と反対側の駆動電極2、3に代えて、全面のメタライズ電極14とした実施例構成である。かかる構造により、入出力間の電気機械結合をより高めることが可能である。

【0040】図10は、図1に示す構造に対し、駆動電極2、3の更なる拡張的变形例である。駆動電極2、3の両側に反射器用のグレーティング電極15、16を形成したものである。圧電基板1の端面での反射に代え、グレーティング電極15、16において弹性波の反射を行わす構成である。

【0041】かかる構成により、端面反射型振動子における圧電基板端面の加工精度の影響を受けないので製造が容易となる。

【0042】図11は、図10の実施例の变形例であり、グレーティング電極15、16に代え、圧電基板1上の駆動電極2、3の両側に反射用のグレーティング電極17、18をエッチング等で形成したものである。

【0043】次に、図1の構成において、電極パッド4、5に接続されない側の駆動電極2、3の利用例を説明する。

【0044】図12は、図1の構成の圧電素子において、電極パッド4、5に接続されない側の駆動電極2、3間を電気的に短絡又は、インピーダンス19で終端した構成である。かかる実施例では、図9に示す圧電基板1の一面をメタライズ電極14とした構成と実質的に同様の効果が得られる。

【0045】これまで、本発明の実施例として、圧電振動子を例に説明したが、本発明の適用はこれに限られない。すなわち、本発明の原理に基づいて温度安定度及び容量比を改善した圧電素子を用いてフィルタを得ることができる。

【0046】図13は、図1の構成の圧電基板1の断面を示す図である。表裏面の駆動電極2、3を電気的に端子20-21間及び20'-21'間に接続している。したがって、端子20-20'及び21-21'をそれぞれ入出力電極とすることによりフィルタを構成するものである。かかる構成においては、フィルタ素子の小型

化が可能である。

【0047】そして、図13の構成では、発生された弹性波は、圧電基板1をその厚さ方向に伝搬して単体側の出力電極により検知される。したがって、機能として、厚み滑り振動子の機能も有していると考えることができる。

【0048】図14は、先の実施例のいずれかにおいて圧電基板1の一面に二組の駆動電極I、IIを形成したフィルタを示す図である。すなわち、圧電基板1の駆動電極2、3を2組続した構成である。圧電基板1の他面上は、先に示した実施例と同様に図1、図6、図9等の電極構成とすることが可能である。これにより、上記の圧電基板1の一面内に形成された二組の駆動電極I、II間の電極ギャップ30を通して電気的に結合し、温度安定度の高いフィルタが得られる。

【0049】さらに、図15は、先の実施例のいずれかにおいて圧電基板1の一面に二組の駆動電極I、IIを並列に配置した構成である。この圧電基板1の他面上は、先に示した実施例と同様に図1、図6、図9等の電極構成とすることが可能である。これにより、上記の圧電基板1の一面内に形成された二組の駆動電極I、II間の空間ギャップ31を通して音響的に結合し、温度安定度の高いフィルタが得られる。

【0050】ここで、本発明に適用される圧電基板1の切り出しについて説明する。結晶回転角の定義が図16に示される。一般に圧電基板材料としてLiTaO₃基板あるいはLiTaO₃基板が用いられる。圧電基板1の結晶軸Zを中心Y軸を回転する回転Yカットで、振動の伝播方向はX方向である。

【0051】図17、18に、LiTaO₃基板、図19、20にLiNbO₃基板における回転角に対する音速(図17、図19)及び、電気機械結合係数(図18、図20)の関係を示す。LiTaO₃基板は回転角33°の時(図18)、LiNbO₃基板は回転角36°の時(図20)、それそれ結合係数は最大となる。なお、前記回転角は、本発明の効果を得るために、36°±20°の範囲が許容可能である。

【0052】したがって、本発明の適用にあたって、かかる電気機械結合係数が最大となる結晶回転角で切り出した圧電基板を用いることが有利である。

【0053】

【発明の効果】以上図面に従い説明したように、本発明によれば圧電基板を伝播する振動の波長以下に薄板化することで、温度に対する高安定化や容量比の小さな弹性波振動子の提供が可能となる。また、低周波帯の小型化および高周波帯の安定した弹性振動子製造ができ、コストダウンに寄与するところが大きい。

【図面の簡単な説明】

【図1】本発明による弹性波素子の第1の実施例を示す圧電素子の斜視図である。

【図2】図1に示す構成の圧電素子の電気的等価回路を示す図である。

【図3】図1の構成の圧電素子について、波長入で正規化した基板厚み(H/λ)と容量比(τ)の関係を示す図である。

【図4】図1の構成の圧電素子の温度特性を示す図である。

【図5】図1の構成の圧電素子の温度特性を従来構成の圧電素子と比較した図である。

【図6】本発明の他の実施例構成を示す図である。

【図7】図6の構成における圧電基板を浮かせる長さと共振抵抗との関係を示す図である。

【図8】本発明の駆動電極に関する他の実施例構成を示す図である。

【図9】本発明の駆動電極に関する更に他の実施例構成を示す図である。

【図10】図1に示す構造に対し、駆動電極2、3の異なる拡張的変形例である。

【図11】図10の実施例の変形例を示す図である。

【図12】図1の構成の圧電素子において、電極パッド4、5に接続されない側の駆動電極2、3間を電気的に短絡又は、負荷インピーダンス19で終端した構成である。

【図13】図1の構成の圧電基板1の断面を示し、フィルタ構成を説明する図である。

【図14】図1に示す圧電基板1の一面に二組の駆動電極I、IIを形成したフィルタを示す図である。

【図15】図1に示す圧電基板1の一面に二組の駆動電極I、IIを並列に配置した構成である。

【図16】結晶回転角の定義を示す図である。

【図17】LiTaO₃基板における回転角に対する音速の関係を示す図である。

【図18】LiTaO₃基板における回転角に対する電気機械結合係数の関係を示す図である。

【図19】LiNbO₃基板における回転角に対する音速の関係を示す図である。

【図20】LiNbO₃基板における回転角に対する電気機械結合係数の関係を示す図である。

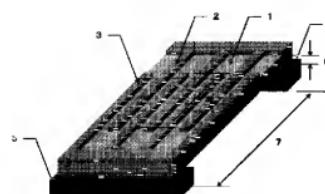
【符号の説明】

1	圧電基板
2, 3	駆動電極
4, 5	パッド電極
6	素子厚み(II)
7	パッド電極間の距離(LF)
8	駆動電極交差長
9	素子厚み
10, 11	側面電極
12	メタライズ電極
13, 14	グレーディング電極
15, 16(15', 16')	電気的ライン

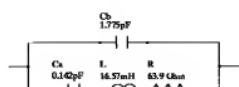
17, 18
19 電気的ライン
グループ

20, 21 キャップ

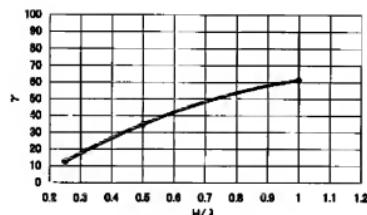
【図1】



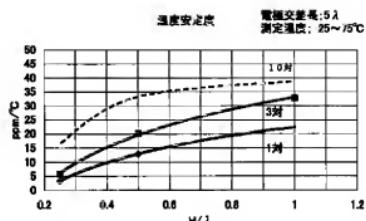
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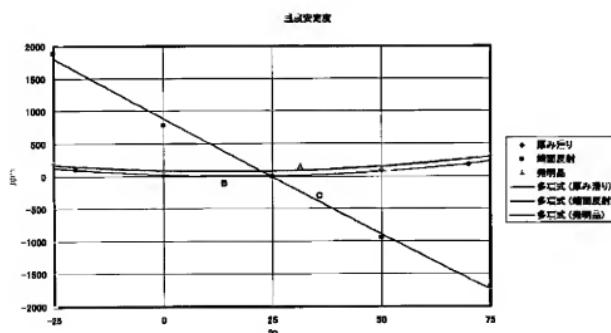
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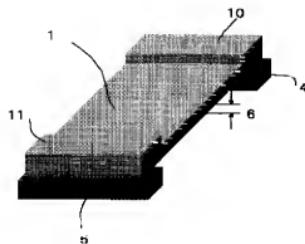
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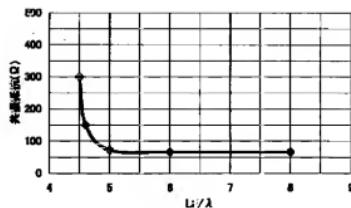
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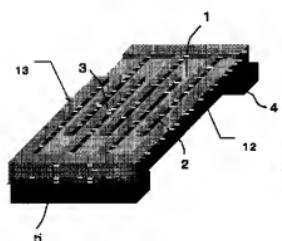
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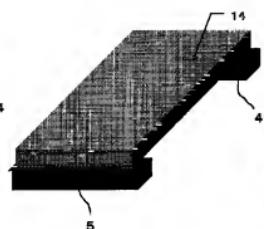
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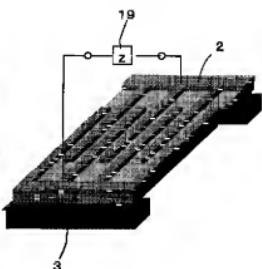
【図8】



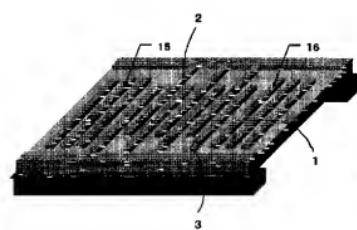
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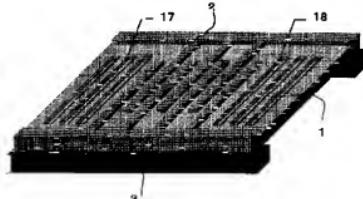
【図12】



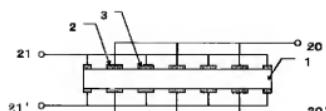
【図10】



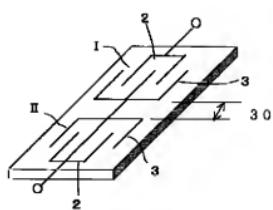
【図11】



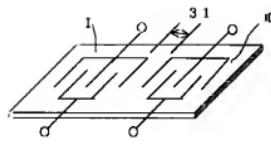
【図13】



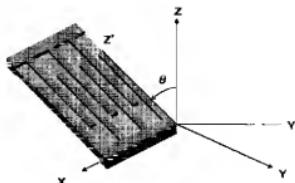
【図14】



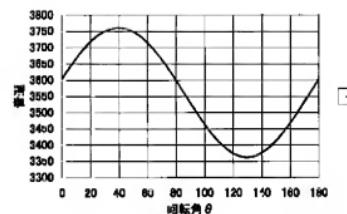
【図15】



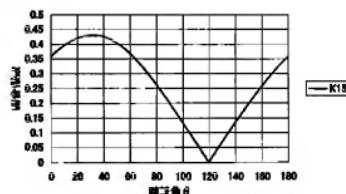
【図16】



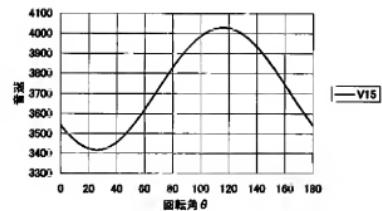
【図17】



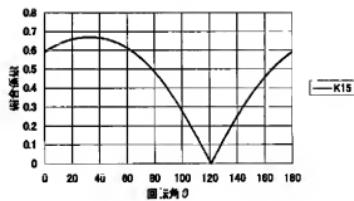
【図18】



【図19】



【図20】



フロントページの続き

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(54) SURFACE ACOUSTIC WAVE ELEMENT



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a surface acoustic wave(SAW) element having new configuration, with which temperature fluctuation characteristics similar to a thickness- shear vibrator can be obtained and a practical capacitance ratio can be reduced by basically using the vibration principle of an end face

reflection type vibrator.

SOLUTION: This element has a piezoelectric substrate and an cord electrode formed on any one of front and rear sides of the piezoelectric substrate, the side to propagate the SAW vibration, which is generated by the cord electrode, on the piezoelectric substrate is made mechanically free and further, the thickness of the piezoelectric substrate is reduced rather than a wavelength λ of the SAW vibration.

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registration]

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CLAIMS

[Claim(s)]

[Claim 1] The elastic wave component characterized by having a piezo-electric substrate and the blind-like electrode of said piezo-electric substrate formed in one field of the front flesh sides at least, having made free mechanically the field which spreads said piezo-electric substrate of the elastic wave oscillation generated with said blind-like electrode, and making thickness of said piezo-electric substrate further smaller than the wavelength lambda of said elastic wave oscillation.

[Claim 2] The elastic wave component to which thickness of said piezo-electric substrate is characterized by being below 0.5λ to the wavelength lambda of said elastic wave oscillation in claim 1.

[Claim 3] The elastic wave component characterized by an oscillation [in / the blind-like electrode of the same pattern is formed in front flesh-side both sides at least, and / front flesh-side both sides of said piezo-electric substrate] of said piezo-electric substrate carrying out joint resonance in claim 1.

[Claim 4] The elastic wave component to which it has a fixed part in claim 1 or 3 to the ends part which an elastic wave oscillation of said piezo-electric substrate fully decreases, and distance between said fixed parts is characterized by being more than 5λ to the wavelength lambda of said elastic wave oscillation.

[Claim 5] The elastic wave component characterized by connecting electrically the blind-like inter-electrode formed in front flesh-side both sides of said piezo-

electric substrate with the electrode which the electrode was formed in the side face of said piezo-electric substrate, and was formed in this side face in claim 3.

[Claim 6] The elastic wave component characterized by forming the solid electrode in claim 1 all over the field in which the blind-like electrode of said piezo-electric substrate was formed, and an opposite hand.

[Claim 7] The elastic wave component characterized by making the end face of said piezo-electric substrate into the reflector of said elastic wave oscillation in claim 1.

[Claim 8] The elastic wave component characterized by forming the grating electrode for reflectors, or the groove in the both sides of the blind electrode formed in said piezo-electric substrate in claim 1.

[Claim 9] The elastic wave component characterized by considering as the configuration which carried out termination of one side of the blind electrode formed in front flesh-side both sides of said piezo-electric substrate by the short circuit or load impedance electrically in claim 3.

[Claim 10] The elastic wave component characterized by starting crystallographic-axis bearing by the envelopment which rotated 36**20 degrees of Y-axes focusing on the Z-axis, and making propagation of an elastic oscillation the direction of X in claim 1, using LiTaO₃ or LiNbO₃ substrate as said piezo-electric substrate.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] Especially this invention relates to the elastic wave component which realized high stabilization of a RF band about an elastic wave component.

[0002]

[Description of the Prior Art] In recent years, RF-izing and high stabilization of elastic wave components, such as vibrator for microcomputer clocks for example, and an oscillator, with which it is used for electronic equipment are needed with RF-izing of the clock frequency of electronic equipment.

[0003] By the special thing, the end-face reflective mold vibrator which used the BGS (Bleustein-Gulyaev-Shimizu/Nakamura) wave is used in use [what generally used thickness slip vibration] by the Prior art in an elastic wave component.

[0004] In the aforementioned thickness-slip-vibration child, an electrode is prepared in both sides of a substrate, a driving signal is given to inter-electrode [those], and an oscillatory wave is a configuration produced in the thickness direction of a substrate. Therefore, it takes for an oscillatory wave to turn into a RF, and the thickness of a component substrate becomes thin, and thickness precision is important. For this reason, if the thickness-slip-vibration child had, the processing technique of a component with a high precision was needed.

[0005] It is the configuration which an elastic wave produces on a substrate front face with the actuation electrode formed in the whole surface of a substrate in end-face reflective mold vibrator on the other hand. For this reason, since it does not depend for oscillation frequency on the thickness of a component substrate, processing of a component has the description of being comparatively easy. However, compared with the thickness-slip-vibration child, it has the problem that

change of a frequency is large, according to the temperature environment to be used.

[0006] Furthermore, generally in end-face reflective mold vibrator, the application was restricted greatly [the ratio (capacity factor) of the capacity and the resistance component which exist in the resistance component and serial in the equal circuit expressed fundamentally in a parallel resonant circuit, and the capacity which exists in juxtaposition] for this reason.

[0007]

[Problem(s) to be Solved by the Invention] Therefore, the object of this invention is to offer the elastic wave component of a new configuration of that the same temperature fluctuation property as said thickness-slip-vibration child is acquired, and a practical capacity factor can be made small, using fundamentally the oscillating principle of the above-mentioned end-face reflective mold vibrator.

[0008]

[Means for Solving the Problem] In view of the object of above-mentioned this invention, the elastic wave component which this invention person used to acquire a desirable property with the approach on a new configuration, and follows this invention It has a piezo-electric substrate and the blind-like electrode of said piezo-electric substrate formed in one field of the front flesh sides at least. It is characterized by having made free mechanically the field which spreads said piezo-electric substrate of the elastic wave oscillation generated with said blind-like electrode, and making thickness of said piezo-electric substrate further smaller than the wavelength λ of said elastic wave oscillation.

[0009] As an example of a gestalt of the desirable operation of an elastic wave component which attains the object of above-mentioned this invention, thickness of said piezo-electric substrate is characterized by being below 0.5λ to the wavelength λ of said elastic wave oscillation.

[0010] Furthermore, it is characterized by an oscillation [in / the blind-like electrode of the same pattern is formed in front flesh-side both sides at least, and / front flesh-side both sides of said piezo-electric substrate] of said piezo-electric

substrate carrying out joint resonance as an example of a gestalt of the desirable operation of an elastic wave component which attains the object of above-mentioned this invention.

[0011] Moreover, it has a fixed part to the ends part which an elastic wave oscillation of said piezo-electric substrate fully decreases as an example of a gestalt of the desirable operation of an elastic wave component which attains the object of above-mentioned this invention, and distance between said fixed parts is characterized by being more than 5λ to the wavelength λ of said elastic wave oscillation.

[0012] It is characterized by connecting electrically the blind-like inter-electrode formed in front flesh-side both sides of said piezo-electric substrate with the electrode which the electrode was formed in the side face of said piezo-electric substrate, and was formed in this side face further again as an example of a gestalt of the desirable operation of an elastic wave component which attains the object of above-mentioned this invention.

[0013] Furthermore, it is characterized by forming the solid electrode all over the field in which the blind-like electrode of said piezo-electric substrate was formed, and an opposite hand as an example of a gestalt of the desirable operation of an elastic wave component which attains the object of above-mentioned this invention.

[0014] Moreover, it is an example of a gestalt of the desirable operation of an elastic wave component which attains the object of above-mentioned this invention. It is characterized by making the end face of said piezo-electric substrate into the reflector of said elastic wave oscillation.

[0015] Furthermore, it is characterized by forming the grating electrode for reflectors, or the groove in the both sides of the blind electrode formed in said piezo-electric substrate as an example of a gestalt of the desirable operation of an elastic wave component which attains the object of above-mentioned this invention.

[0016] It is characterized by considering electrically one side of the blind

electrode formed in front flesh-side both sides of said piezo-electric substrate as a short circuit or the configuration which carried out termination by load impedance further again as an example of a gestalt of the desirable operation of an elastic wave component which attains the object of above-mentioned this invention.

[0017] Furthermore, it is characterized by starting the example of a gestalt of the desirable operation of an elastic wave component which attains the object of above-mentioned this invention by the envelopment to which crystallographic-axis bearing rotated 36**20 degrees of Y-axes focusing on the Z-axis, using LiTaO₃ or LiNbO₃ substrate as said piezo-electric substrate, and making propagation of an elastic oscillation the direction of X.

[0018] The description of this invention becomes clear from the gestalt of the implementation further explained with reference to the following drawings.

[0019]

[Embodiment of the Invention] Drawing 1 is the perspective view of a piezoelectric device showing the 1st example by this invention. The actuation electrodes 2 and 3 are formed by the same pattern on front flesh-side both sides of the piezo-electric substrate 1. Furthermore, it has the electrode pads 4 and 5 joined to the actuation electrodes 2 and 3 electrically mechanically by the longitudinal direction of the piezo-electric substrate 1, and outputs and inputs through these electrode pads 4 and 5 with the actuation electrodes 2 and 3 by the side of the whole surface of the piezo-electric substrate 1 (drawing 1 rear-face side).

[0020] The electrical equivalent circuit of this piezoelectric device is shown in drawing 2 . It has the capacity C_b by which parallel connection is carried out to capacity calcium, an inductance L and the series connection of Resistance R, and this series connection. the capacity factor which made reference previously - the ratio of said series capacitance calcium and juxtaposition capacity C_b -- gamma -- pointing out -- gamma=C_b/calcium It is expressed. If this capacity factor gamma is large, it is known by this contractor that a limit of utilization of a

piezoelectric device will become large.

[0021] Next, the example of 1 prototype of the piezoelectric device which has the configuration of drawing 1 is explained below. An elastic wave oscillation is generated on the front face of the piezo-electric substrate 1 by the actuation electrodes 2 and 3 formed in the rear face of drawing 1 connected to the electrode pads 4 and 5.

[0022] and -- this -- an elastic wave -- an oscillation -- wavelength -- λ -- ** - - having carried out -- the time -- a prototype -- an example -- piezo-electricity -- a substrate -- one -- thickness -- (H) -- six -- 0.25 -- λ -- relation -- it is -- an electrode -- a pad -- four -- five -- the air -- having floated -- a part -- die length -- (LF) -- seven -- 15λ -- it was .

[0023] The die length 8 of the logarithm of 5λ and an electrode to which the blind-like electrode by the actuation electrodes 2 and 3 intersects actuation electrode material using NiCr/Au (50nm of thickness, 400nm) is one pair. A blind-like electrode is arranged at the table rear face, and the electrode, i.e., the actuation electrode electrically connected to the electrode pads 4 and 5, to drive is only the rear-face side of drawing 1 .

[0024] Furthermore, it was started by the piezo-electric substrate 1 about the crystallographic axis XYZ at the include angle which rotated 40 degrees of Y-axes focusing on the Z-axis, and LiTaO₃ substrate of the direction propagation of 40 degreeY cut X which has the direction of oscillating wave propagation of the direction of X was used.

[0025] It seemed that the constant about each element of the equal circuit where the vibrator made as an experiment on condition that the above-mentioned configuration is shown in drawing 2 was shown in the following table.

[0026]

[A table 1]

R	63.9	Ω
L	16.57	m H
C _a	0.142	p F
C _b	1.775	p F

Therefore, the capacity factor gamma of the above-mentioned example of a prototype is $\gamma = C_b / \text{calcium} = 12.5$.

[0027] Drawing 3 is drawing showing the substrate thickness (H/λ) and the relation of a capacity factor (gamma) which were normalized on wavelength λ about the piezoelectric device of the configuration of above-mentioned drawing 1. He can understand that a capacity factor decreases as the piezoelectric substrate 1 is sheet-metal-ized so that he can understand easily from this drawing. The capacity factor of the conventional piezoelectric device was the magnitude of 70-80 as a general value. On the other hand, it is possible by making substrate thickness (H/λ) or less into one according to the principle of this invention to obtain the capacity factor below the capacity factor in the conventional piezoelectric device. Furthermore, it is remarkable as effectiveness to make thickness of the piezo-electric substrate 1 below into 0.5λ.

[0028] Drawing 4 is drawing showing the piezo-electric substrate thickness (H/λ) which normalized the die length (8) which an electrode intersects about the piezoelectric device of the configuration of drawing 1 on the wavelength λ when making the logarithm of 5λ and an electrode into one pair and three pairs, and the relation between temperature rate-of-change 10-6 (ppm) / **.

[0029] so that the thickness (H/λ) of this drawing to the piezo-electric substrate 1 is thin -- an electrode -- few logarithms can understand that temperature stability (whenever [temperature rate-of-change]) becomes high, so that there are, in addition, drawing 4 -- setting -- an electrode -- if a logarithm increases -- temperature stability -- an electrode -- it is not based on a logarithm but it is thought that it converges on constant value. therefore, drawing 4 --

setting -- an electrode -- the broken line of a logarithm 10 is a predicted value.

[0030] The temperature stability in the conventional piezoelectric device can make the temperature rate of change in the conventional piezoelectric device or less into 40×10 to six to generally being about 40 ppm/degree C by making thickness (H/λ) of the piezo-electric substrate 1 or less into one.

[0031] Drawing 5 is drawing which compared the property of a thickness-slip-vibration child and end-face reflective vibrator, and the property of this invention for temperature rate of change as reference-value zero at the room temperature of 25 degrees C further. An axis of abscissa is made into temperature among drawing, an axis of ordinate is made into rate of change ppm, and the temperature fluctuation property and ultimate lines B and C of thickness slipping end-face vibrator of ultimate lines A are the temperature fluctuation properties of end-face reflective vibrator and the piezoelectric transducer of this invention configuration, respectively.

[0032] Here, temperature rate of change shows the quadratic curve property of having the general lowest value as top-most vertices. In drawing 5 , as explained previously, the thickness-slip-vibration child of the temperature fluctuation property (ultimate lines A) is stable, and has top-most vertices near the ordinary temperature (25 degrees C). On the other hand, near the ordinary temperature (25 degrees C) of end-face reflective vibrator, temperature fluctuation (ultimate lines B) is large, and the top-most vertices of the characteristic curve are further located from ordinary temperature in Haruka or a top (it is understood that it is at least 75 degrees C or more in drawing 5). Although this invention is similar to end-face reflective vibrator as basic structure, the temperature fluctuation property (special envoy line C) of approximation to a thickness-slip-vibration child is acquired.

[0033] In order to acquire the temperature stability by this invention, and the effectiveness of reduction of a capacity factor from the above-mentioned explanation here, only the part which the elastic oscillation generated with the actuation electrodes 2 and 3 spreads should be the range of predetermined

substrate thickness (H/lambda).

[0034] Therefore, the example structure of drawing 6 is possible as structure for making handling easy. In drawing 6 , it is the both ends corresponding to the electrode pads 4 and 5 of the piezo-electric substrate 1, and is the structure which makes only the part 10 which fixes a piezoelectric device, and the field which elastic oscillations other than 11 spread below predetermined thickness (1lambda). At these both ends, the elastic wave oscillation is fully decreased.

[0035] Moreover, when setting to (LF) the die length of the field which the elastic oscillation which is the die length between the parts 10 and 11 which fix the piezoelectric device in the example structure of drawing 6 spreads, relation with resonance resistance is obtained. Drawing 7 is drawing showing the relation between LF in the example structure of drawing 7 , and resonance resistance. He can understand that the constant value of desirable small resonant resistance will be obtained from this drawing if LF is more than 5lambda.

[0036] Next, in the basic structure of this invention of above-mentioned drawing 1 , the extended modification of the actuation electrodes 2 and 3 is explained.

[0037] Drawing 8 is the 1st extended modification of the actuation electrodes 2 and 3 to the structure shown in drawing 1 . It is the example configuration in which the side-face electrodes 12 and 13 which connect electrically the actuation electrodes 2 and 3 formed in both sides of the piezo-electric substrate 1 were formed on the side face of the piezo-electric substrate 1.

[0038] Thus, in the table rear face of the piezo-electric substrate 1, it is possible by having the side-face electrodes 12 and 13 for an elastic oscillation to arise, therefore to raise the actuation effectiveness of an oscillation more.

[0039] Drawing 9 is the 2nd extended modification of the actuation electrodes 2 and 3 to the structure shown in drawing 1 . It is the example configuration which replaced with the actuation electrodes 2 and 3 of a side and an opposite hand connected to one side 4 and 5, i.e., the I/O electrode pads, of the actuation electrodes 2 and 3 formed in both sides of the piezo-electric substrate 1, and was used as the entire metallizing electrode 14. It is possible to raise electric machine

association during I/O more according to this structure.

[0040] Drawing 10 is the further extended modification of the actuation electrodes 2 and 3 to the structure shown in drawing 1 . The grating electrodes 15 and 16 for reflectors are formed in the both sides of the actuation electrode 2.3. It replaces with the echo by the end face of the piezo-electric substrate 1, and is a ***** configuration about an echo of an elastic wave in the grating electrodes 15 and 16.

[0041] By this configuration, since it is not influenced of the process tolerance of the piezo-electric substrate end face in end-face reflective mold vibrator, manufacture becomes easy.

[0042] Drawing 11 is the modification of the example of drawing 10 , is replaced with the grating electrodes 15 and 16, and forms the grooves 17 and 18 for an echo in the both sides of the actuation electrodes 2 and 3 on the piezo-electric substrate 1 by etching etc.

[0043] Next, in the configuration of drawing 1 , the example of utilization of the near actuation electrodes 2 and 3 which are not connected to the electrode pads 4 and 5 is explained.

[0044] Drawing 12 is the configuration which carried out termination of between the near actuation electrode 2 which is not connected to the electrode pads 4 and 5, and 3 with the short circuit or the impedance 19 electrically in the piezoelectric device of the configuration of drawing 1 . In this example, the same effectiveness is substantially acquired with the configuration which used as the metallizing electrode 14 the whole surface of the piezo-electric substrate 1 shown in drawing 9 .

[0045] Until now, as an example of this invention, although the piezoelectric transducer was explained to the example, application of this invention is not restricted to this. That is, a filter can be obtained using the piezoelectric device which has improved temperature stability and a capacity factor based on the principle of this invention.

[0046] Drawing 13 is drawing showing the cross section of the piezo-electric

substrate 1 of the configuration of drawing 1 . The actuation electrodes 2 and 3 on the rear face of a table are electrically connected between terminals 20-21 and between 20 '-21'. Therefore, a filter is constituted by using terminal 20-20' and 21-21' as an I/O electrode, respectively. In this configuration, the miniaturization of a filter element is possible.

[0047] And with the configuration of drawing 13 , the generated elastic wave spreads the piezo-electric substrate 1 in the thickness direction, and is detected with the output electrode by the side of a simple substance. Therefore, it is possible as a function that it also has the thickness-slip-vibration child-function.

[0048] Drawing 14 is drawing showing the filter which formed 2 sets of actuation electrodes I and II on the whole surface of the piezo-electric substrate 1 in either of the previous examples. That is, it is the configuration of having ****(ed) the actuation electrodes 2 and 3 of the piezo-electric substrate 1 2 sets. On the other hand, a top can be considered as electrode configurations, such as drawing 1 , drawing 6 , and drawing 9 , like the example of the piezo-electric substrate 1 shown previously. This joins together electrically through the electrode gap 30 between 2 sets of actuation electrodes I and II formed in the whole surface of the above-mentioned piezo-electric substrate 1, and a filter with high temperature stability is obtained.

[0049] Furthermore, drawing 15 is a configuration which has arranged 2 sets of actuation electrodes I and II to juxtaposition on the whole surface of the piezo-electric substrate 1 in either of the previous examples. On the other hand, a top can be considered as electrode configurations, such as drawing 1 , drawing 6 , and drawing 9 , like the example of this piezo-electric substrate 1 shown previously. This joins together acoustically through the space gap 31 between 2 sets of actuation electrodes I and II formed in the whole surface of the above-mentioned piezo-electric substrate 1, and a filter with high temperature stability is obtained.

[0050] Here, logging of the piezo-electric substrate 1 applied to this invention is explained. The definition of a crystal angle of rotation is shown in drawing 16 .

Generally LiTaO₃ substrate or LiTaO₃ substrate is used as a piezo-electric substrate ingredient. It is the revolution Y cut which rotates a Y-axis centering on the crystallographic axis Z of the piezo-electric substrate 1, and the propagation of an oscillation is the direction of X.

[0051] The relation between the acoustic velocity (drawing 17 , drawing 19) over the angle of rotation in LiNbO₃ substrate and an electromechanical coupling coefficient (drawing 18 , drawing 20) is shown in LiTaO₃ substrate, drawing 19 , and 20 drawing 17 and 18. In LiNbO₃ substrate, a coupling coefficient serves as [LiTaO₃ substrate] max, respectively at the time (drawing 20) of 36 degrees of angles of rotation at the time (drawing 18 R>8) of 33 degrees of angles of rotation. In addition, said angle of rotation can permit the 36-degree range of **20 degrees, in order to acquire the effectiveness of this invention.

[0052] Therefore, it is advantageous to use the piezo-electric substrate cut down by the crystallographic-axis angle of rotation from which this electromechanical coupling coefficient serves as max in application of this invention.

[0053]

[Effect of the Invention] As explained according to the drawing above, according to this invention, the high stabilization to temperature and offer of the small elastic wave vibrator of a capacity factor are attained by sheet-metal-izing below on the wavelength lambda of the oscillation which spreads a piezo-electric substrate. Moreover, the place which elastic vibrator manufacture by which the miniaturization of a low frequency band and the RF band were stabilized can be performed, and contributes to a cost cut is large.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the perspective view of a piezoelectric device showing the 1st example of the elastic wave component by this invention.

[Drawing 2] It is drawing showing the electrical equivalent circuit of the piezoelectric device of a configuration of being shown in drawing 1 .

[Drawing 3] It is drawing showing the substrate thickness (H/λ) and the relation of a capacity factor (γ) which were normalized on wavelength λ about the piezoelectric device of the configuration of drawing 1 .

[Drawing 4] It is drawing showing the temperature characteristic of the piezoelectric device of the configuration of drawing 1 .

[Drawing 5] It is drawing [the piezoelectric device of a configuration / temperature characteristic / of the piezoelectric device of the configuration of drawing 1] conventionally.

[Drawing 6] It is drawing showing other example configurations of this invention.

[Drawing 7] It is drawing showing the relation of the die length and resonant resistance which float the piezo-electric substrate in the configuration of drawing 6 .

[Drawing 8] It is drawing showing other example configurations about the actuation electrode of this invention.

[Drawing 9] It is drawing showing the example configuration of further others about the actuation electrode of this invention.

[Drawing 10] It is the further extended modification of the actuation electrodes 2 and 3 to the structure shown in drawing 1 .

[Drawing 11] It is drawing showing the modification of the example of drawing 10 .

[Drawing 12] In the piezoelectric device of the configuration of drawing 1 , it is the configuration which carried out termination of between the near actuation electrode 2 which is not connected to the electrode pads 4 and 5, and 3 by the short circuit or load impedance 19 electrically.

[Drawing 13] It is drawing which shows the cross section of the piezo-electric substrate 1 of the configuration of drawing 1 , and explains a filter configuration.

[Drawing 14] It is drawing showing the filter in which 2 sets of actuation electrodes I and II were formed on the whole surface of the piezo-electric substrate 1 shown in drawing 1 .

[Drawing 15] It is the configuration which has arranged 2 sets of actuation electrodes I and II to juxtaposition on the whole surface of the piezo-electric substrate 1 shown in drawing 1 .

[Drawing 16] It is drawing showing the definition of a crystal angle of rotation.

[Drawing 17] It is drawing showing the relation of the acoustic velocity over the angle of rotation in LiTaO₃ substrate.

[Drawing 18] It is drawing showing the relation of the electromechanical coupling coefficient to the angle of rotation in LiTaO₃ substrate.

[Drawing 19] It is drawing showing the relation of the acoustic velocity over the angle of rotation in LiNbO₃ substrate.

[Drawing 20] It is drawing showing the relation of the electromechanical coupling coefficient to the angle of rotation in LiNbO₃ substrate.

[Description of Notations]

1 Piezo-electric Substrate

2 Three Actuation electrode

4 Five Pad electrode

6 Component Thickness (H)

7 Pad Inter-electrode Distance (LF)

8 Actuation Electrode Crossover Length

9 Component Thickness

10 11 Side-face electrode
12 Metallizing Electrode
13 14 Grating electrode
15 16 (15', 16') Electric line
17 18 Electric line
19 Groove
20 21 Gap

[Translation done.]

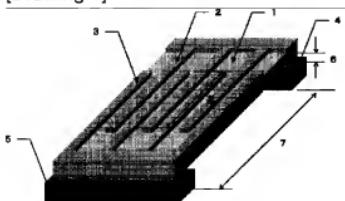
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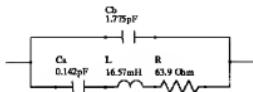
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DRAWINGS

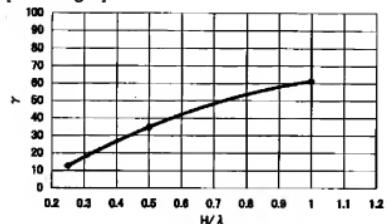
[Drawing 1]



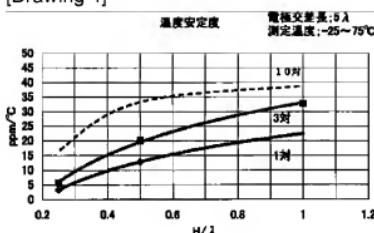
[Drawing 2]



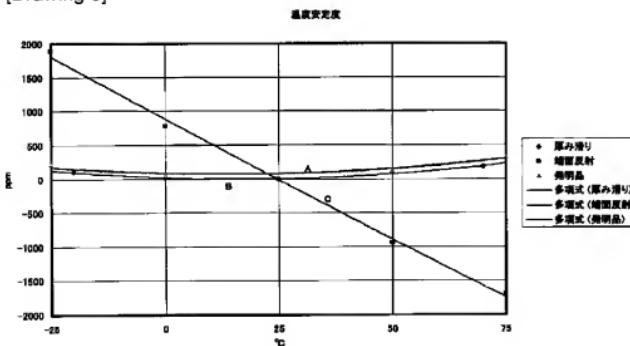
[Drawing 3]



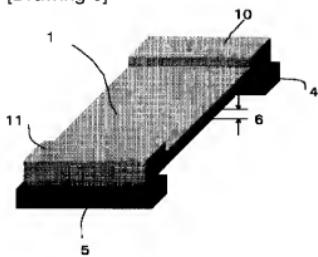
[Drawing 4]



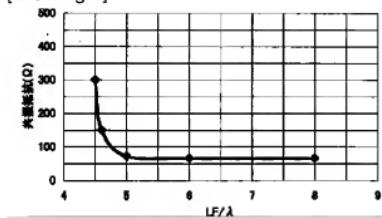
[Drawing 5]



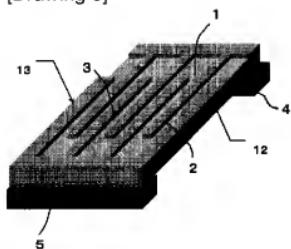
[Drawing 6]



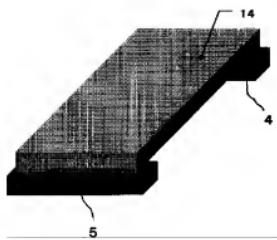
[Drawing 7]



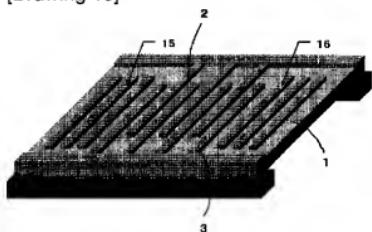
[Drawing 8]



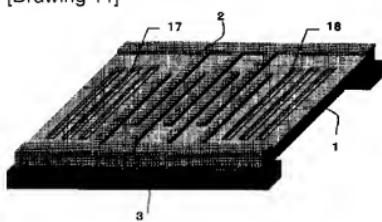
[Drawing 9]



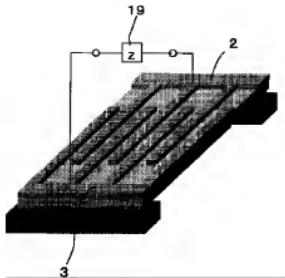
[Drawing 10]



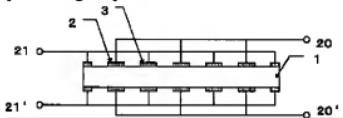
[Drawing 11]



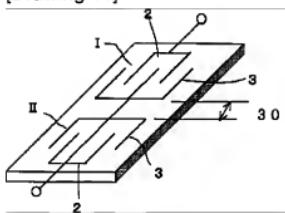
[Drawing 12]



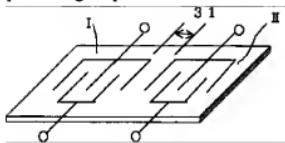
[Drawing 13]



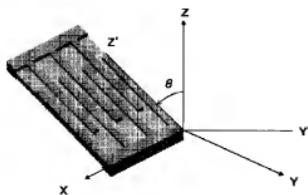
[Drawing 14]



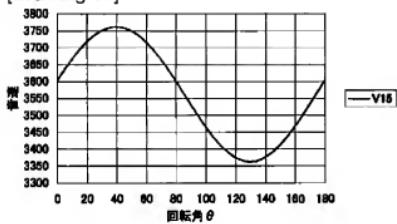
[Drawing 15]



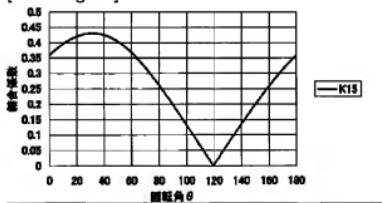
[Drawing 16]



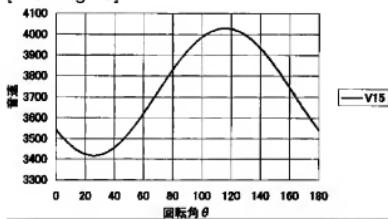
[Drawing 17]



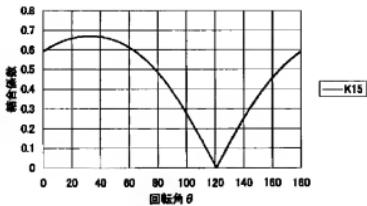
[Drawing 18]



[Drawing 19]



[Drawing 20]



[Translation done.]